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Orbital structure of a meteoric complex in a vicinity of the Earth's orbit by Kazan meteor radar. Types of meteor orbits

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ABSTRACT

The orbital structure of a meteoric complex in a vicinity of the Earth's orbit is substantially defined by conditions of its observation from the Earth. Orientation of aerials of Kazan meteor radar varied each 15 min to the North, East, South and West – the directions to provide the maximal review of northern celestial hemisphere together with the Earth's rotation. Nevertheless, the antiapex area of celestial sphere was practically inaccessible due to influence of the physical factor of small radar sensitivity to meteors with velocities less than 18 km/s. On the contrary, the meteor streams in which movements are backward compared to the Earth's movement, are quite observationally accessible.

In the given work, the data of meteor radar observation from August to November of 1986 are resulted. The conditions of observation have defined some types of orbits: internal orbits with aphelion distance $Q{\sim}1$ AU and with a wide spectrum of perihelion distances and external orbits with perihelion distance $q{\sim}1$ AU and with a wide spectrum of aphelion distances. The majority of all observed orbits are close to circular orbits for which $Q{\sim}1$ AU and $q{\sim}1$ AU. Three-dimensional maps of meteor microstream distribution and numbers of meteors in them by perihelion, by aphelion distances and by inclinations are constructed. Orbital parameters of the most significant meteor streams that have been found out are presented.

1. Introduction

The observed orbital structure of a meteoric complex in a vicinity of the Earth's orbit substantially is defined by conditions of its observation from the Earth, especially when using meteor radars. Radar researches of meteors have more than a semicentenial history of development. A classical engineering of radar researches for the orbital structure was a technique of multi-station receivers for measurement of individual orbits of meteors (Kascheev et al., 1961; Webster and Jones, 2004). However, this technique is quite complex for organizing a long-term monitoring of the orbital structure.

Attempts to use a meteor radar with a goniometer to research meteor streams and sporadic meteors have been undertaken from the very beginning of the radar research (Belkovich et al., 1991). Consecutive steps in this direction are described in works (Jones and Morton, 1977). But till now there was an unsolved problem – the ambiguity of the decision. Because of that we were dealing with low resolution or were studying only major meteor streams. However, in recent years, two scientific teams in Kazan (Belkovich et al., 1997; Sidorov and Kalabanov, 2001; Sidorov et al., 2008) have succeeded in finding an acceptable solution for studying the orbital structure of a meteoric complex based on the goniometric radar measurements.

In this paper we use the results of meteor data computer processing using the original discrete quasi-tomographic method (Sidorov and Kalabanov, 2003). The method is based on the search and analysis of the line intersections of the possible position of observed meteor radiants on the celestial sphere. In this case, the selection of correlated combinations of these intersections is carried out. The method allows to determine small meteor streams ("microstreams") with the number N of more than 6 meteor radio reflections per day (with a discreteness ΔT equal 1 day) and close coordinates of radiants (with angular discreteness $\Delta\psi$, $\Delta\varepsilon$ equal $2^\circ \times 2^\circ$) and close velocities (with a discreteness ΔV equal 3 km/s). On the basis of the results obtained in (Sidorov and Kalabanov, 2003), we proposed the so-called microstream hypothesis. This hypothesis assumes the presence in a meteoric complex of correlated fragments with properties that allow them to be classified as very small stream ("microstream"). The feature of the method is that the decision on the existence of a "microstream" is accepted only if a number of meteors N in a discrete cell of a given resolution ($\Delta\psi$, $\Delta\varepsilon$, ΔV, ΔT) above a certain threshold is detected. Accordingly, it became possible for each detected discrete fragment (microstream) to calculate the average values of the orbit elements.

In work (Sidorov et al., 2004) it is shown that, for the parameters of the Kazan meteor radar, the recorded microstreams can represent

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